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GUTTER CLEANER AND SILO UNLOADER TESTS, A PROGRESS REPORT^{1/}

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INTRODUCTION

During the winter and spring of 1958 an evaluation of the performance of silo unloaders and gutter cleaners was begun on farms located in south-eastern Minnesota as a part of a research program to reduce the labor requirements for dairy-chore operations through the use of electric equipment. Such tests of existing equipment seemed desirable as a basis for evaluating attempts at improvement and to point out deficiencies warranting further study. Existing available information either seemed somewhat outdated or came from areas with more moderate climate.

Because of the difficulties involved in testing such equipment under controlled laboratory conditions, the tests were conducted on farms to obtain data under various conditions and from a number of makes of machines, realizing that comparisons of individual test results or of single variables would not be valid. Despite these limitations, it was believed that the range of results obtained would, in itself, be valuable.

As a basis for the evaluation, the amount of useful accomplishment per kilowatt-hour of electric energy was chosen. For silo unloaders this was the number of pounds of silage unloaded per kilowatt-hour; but for gutter cleaners the number of cubic feet of manure removed per kilowatt-hour was used, because manure could not readily be weighed under the conditions prevailing on most farms.

PROCEDURES

For silo unloaders, recording wattmeters and ammeters were inserted in the electrical supply circuits. A person familiar with the machine operated it normally and measured the amount of silage unloaded during a measured time interval adequate to accumulate an amount of silage compatible with the feed requirements of the particular herd.

For gutter-cleaner tests the recording meters were installed in a similar manner, the volume of the empty spreader was measured, the cleaner was run in the usual way noting the time required to convey all the manure to the spreader (where practicable the cleaner was also allowed to run empty to observe the power required for operating the mechanism), and, finally, the volume of the loaded spreader was measured.

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The electric energy consumed in the tests was computed from charts of recording wattmeters by use of a planimeter, and the results were expressed in pounds, or cubic feet, of material per kilowatt-hour as previously described. The shapes of the demand curves shown by the meters were also quite informative.

RESULTS

The initial tests were performed during the winter of 1958 on a group of farms, selected for other research purposes, on which most of the gutter cleaners and silo unloaders had been in use for several years. The results of the gutter cleaner tests appear in Table 1. Three types of cleaners - continuous chain, belt, and shuttle - and products of five manufacturers are represented. All performed their function satisfactorily and there were no serious owner complaints. The results indicated performance of all makes to be within a reasonably similar range. One type was distinctly outstanding, moving 674 cubic feet of manure per kilowatt-hour of energy, but its use involved other complications, tending to reduce the performance advantages.

In addition to the differences between the various cleaners, differences in barn arrangement and in the proportion of straw in the manure also affect the test results, making individual comparisons unreliable. However, a general range of performance is clearly indicated in which the highest delivery per kilowatt-hour is about three times the lowest.

Table 1. Gutter Cleaner Test Results

Manure Removed per KWH Cu. ft.	Conveyor Length Feet	Gutter Cleaner Make	:	Manure Removed per KWH Cu. ft.	Conveyor Length Feet	Gutter Cleaner Make
674	90	A	:	298	194	D
432	180	B	:	280	195	B
403	165	B	:	251	225	C
336	340	C	:	178	120	E

Results of the initial (winter) trials on silo unloaders appear in Table 2. Products of six manufacturers are represented, including bottom and top unloaders. In several instances successive runs were made with the same machine and these are indicated by letter subscripts. The influence of the operator's handling of the feed mechanism is shown by the considerable differences in the results of these successive trials. Tests 5a and 5b illustrate an extreme difference in performance between frozen and thawed conditions.

The wide variation in the quantities unloaded per kilowatt-hour in the initial trials (the greatest amount was about fifteen times the lowest), coupled with the fact that newer unloaders gave the best performances, indicated a need for information on more recent machines. Consequently, a second series of tests, recorded in Table 3, was arranged with farmers owning current models. Six makes of top unloaders are represented. The data shown include only tests made under favorable unloading conditions in the spring. These will be supplemented with similar trials under adverse conditions during the winter season.

Table 2. Silo Unloader Test Results - Initial

Test :	Silage Characteristics		: Quantity Removed : Silo			
No. :Crop	Condition	Length Cut	Moisture :	Per Min.	Per KWH	Unloader
		Inches	Percent	Pounds	Pounds	Make
<u>Corn:</u>						
1	Thawed	1/4	67	125	2314	A
2a	{ Partly Frozen	1/2	65	132	1995	B
b				109	1825	
3	{ Partly Frozen	7/16	63	158	1925	C
4				58	1045	
5a	Thawed	5/8	68	62	1026	D ₁
b	Frozen	5/8	71	6	145	D ₂
				93 Av.	1470 Av.	
<u>Oats:</u>						
6	Thawed	3/4	54	62	1729	E
7a	{ Partly Frozen	1/2	70	53	1161	F
b				34	840	
<u>Grass:</u>						
8a	{ Partly Frozen	3/8	73	27	905	B
b				15	586	
9a	Thawed	1/2	80	37	755	D ₁
b				14	378	

The unloader performances, too, are affected by additional variables such as silo size, depth of silage, crop material, and the amount of freezing which preclude direct comparisons of the individual results.

CONCLUSIONS AND OBSERVATIONS TO DATE:

1. Dependability is one of the principal characteristics desired by farmers in labor-saving equipment such as gutter cleaners and silo unloaders. This includes both adequate performance of the required task under adverse conditions and freedom from mechanical or electrical troubles. Efficient performance alone is not sufficient.
2. Management greatly affects the performance of both gutter cleaners and silo unloaders.
3. For gutter cleaners, performance of all types tested is reasonably similar, degree of owner satisfaction is high, and differentiation between makes is based primarily on durability of components, availability of service and other similar considerations. Publicly supported research on fundamental principles of operation of the mechanisms tested seems unnecessary.

Table 3. Silo Unloader Test Results - New Models

Silage Characteristics *			Quantity Removed		Silo
Crop	Length Cut	Moisture	Per Min.	Per KWH	Unloader
	Inches	Percent	Pounds	Pounds	Make
<u>Corn:</u>					
	3/4	73	157	3030	G
	3/8	68	210	2680	A
	1/4	72	162	2450	B
	1/2	69	80	2230	A
	1/4	-	173	2120	C
	1/2	69	145	2060	G
	7/16	71	172	1980	G
	3/4	69	123	1960	F
	3/8	66	122	1790	F
	5/8	71	163	1515	H
	3/8	75	107	1450	H
			147 Av.	2110 Av.	
<u>Oats:</u>					
	1/2	74	97	2005	B
	5/8	69	141	1942	A
<u>Grass:</u>					
	5/8	70	51	1220	B
	7/16	71	42	1005	F
	Flail	69	41	974	F

* All tests made with good, unfrozen silage.

4. For silo unloaders, initial trials indicate wide variations in performance, although many are performing satisfactorily and improvement in new models is evident. Further tests should permit a better evaluation of the current situation.
5. The following problems still appear to be associated with use of silo unloaders and should receive further attention:
 - a. Difficulties in unloading grass silage and all frozen silages.
 - b. Need for control systems to reduce the amount of operator supervision required to prevent plugging and still maintain an efficient unloading rate.
 - c. Reduction of corrosion and condensation troubles through improved construction, with due regard for the problems of weight and convenience of assembly and adjustment.
 - d. Improvement in the general quality of electric wiring practices and devices employed, especially on units frequently disassembled by farmers.